Memorandum

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Date: September 2, 2009

To: Steve Hitch, City of Redmond

cc: Larry Grimm, Otak Inc.

From: Patty Dillon & David Hartley

Subject: **HSPF Model Update with Revised Surface Geology**

Pages: 8, including figures

Northwest Hydraulic Consultants (NHC) was retained by the City of Redmond (City) to develop hydrologic and hydraulic models for the City's Overlake drainage basin, and to provide design support to Otak Inc. (Otak) in the designing long-term flow control solutions for the basin. NHC previously developed and calibrated an HSPF model of existing basin conditions, as documented in a May 2009 report. Subsequent to that modeling effort, the City acquired more detailed surface geology mapping for the Overlake basin (Troost and Wisher, 2009). This report documents updates to the HSPF existing conditions model, reflecting the new surface geology as well as other data that have become available since the initial modeling effort.

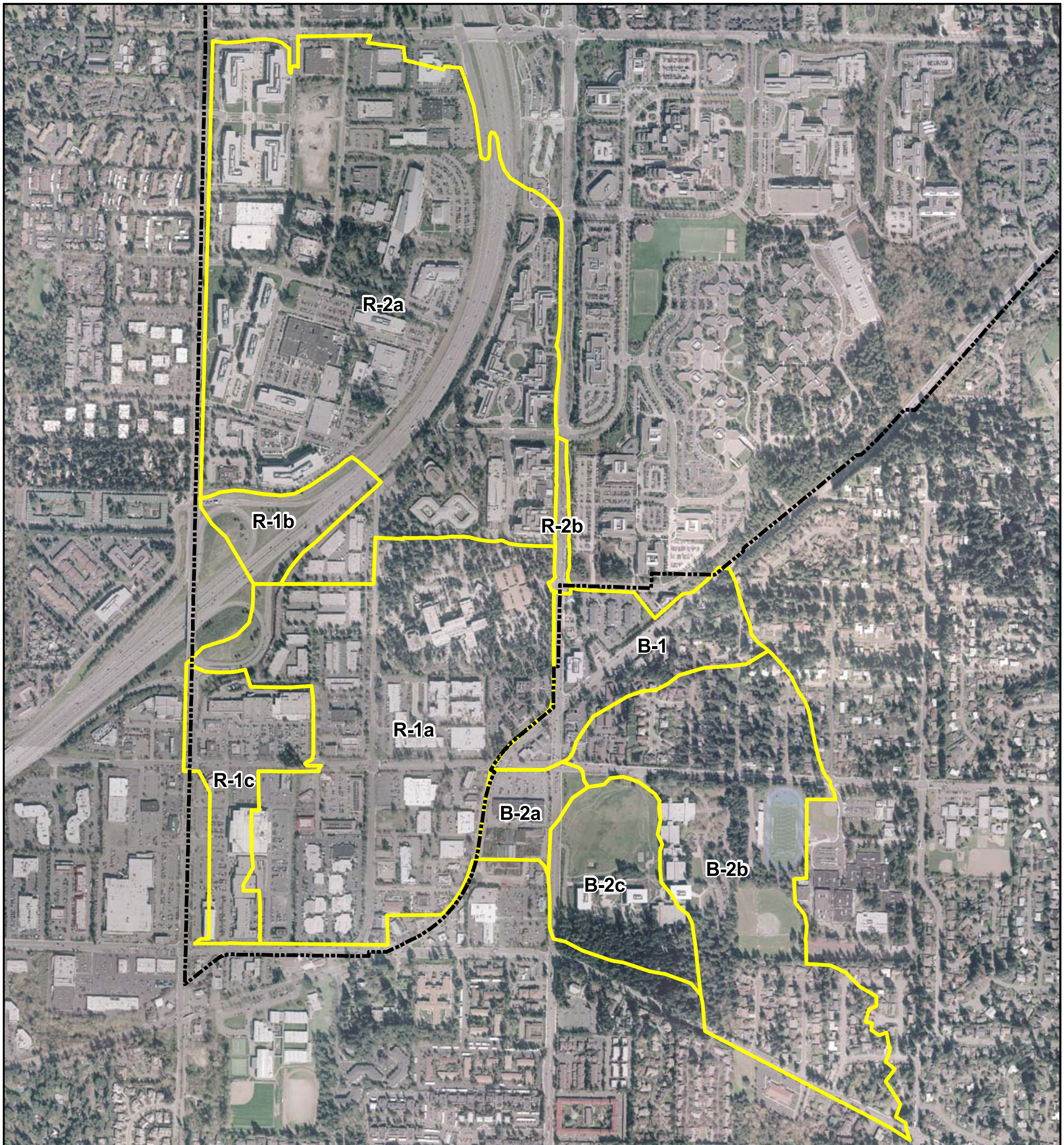
Subbasin Delineation

Subbasin boundaries for the Redmond portion of the Overlake basin have been refined based on field verification of the drainage system in connection with NHC's ongoing hydraulic modeling work in the basin. The most significant change is routing of Subbasin R-1b, representing essentially the SR520/148th Ave NE interchange, out of the basin. Figure 1 shows an updated subbasin map, and subbasin areas are listed in Table 1.

Table 1. Overlake Subbasin Areas

City of Redmond		City of Bellevue	
Subbasin	**Area (ac)**	**Subbasin**	**Area (ac)**
R-1a	111.9	B-1	26.9
R-1b[1]	12.3	B-2a	8.9
R-1c	23.7	B-2b	81.3
R-2a	187.2	B-2c	24.9
R-2b[2]	2.4		
Total	479.5 (464.8 to basin outlet)		

[1]Drains to west along SR520 out of Overlake Watershed.
[2] Drains to Lake Sammamish.

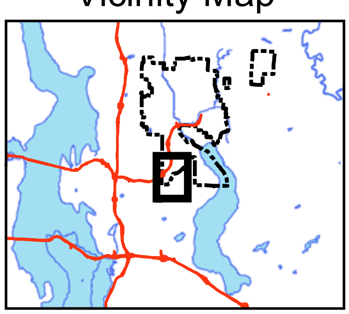


Legend

Redmond City Limit

Overlake Drainage Area

Vicinity Map



CITY OF REDMOND

DRAFT

Overlake H&H Modeling
Updated HSPF Subbasins

Scale - 1:12,000

1,000 500 0 1,000 Feet

coord. syst.: WA State Plane N	horz. datum: HARN	horz. units: feet
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Figure 1

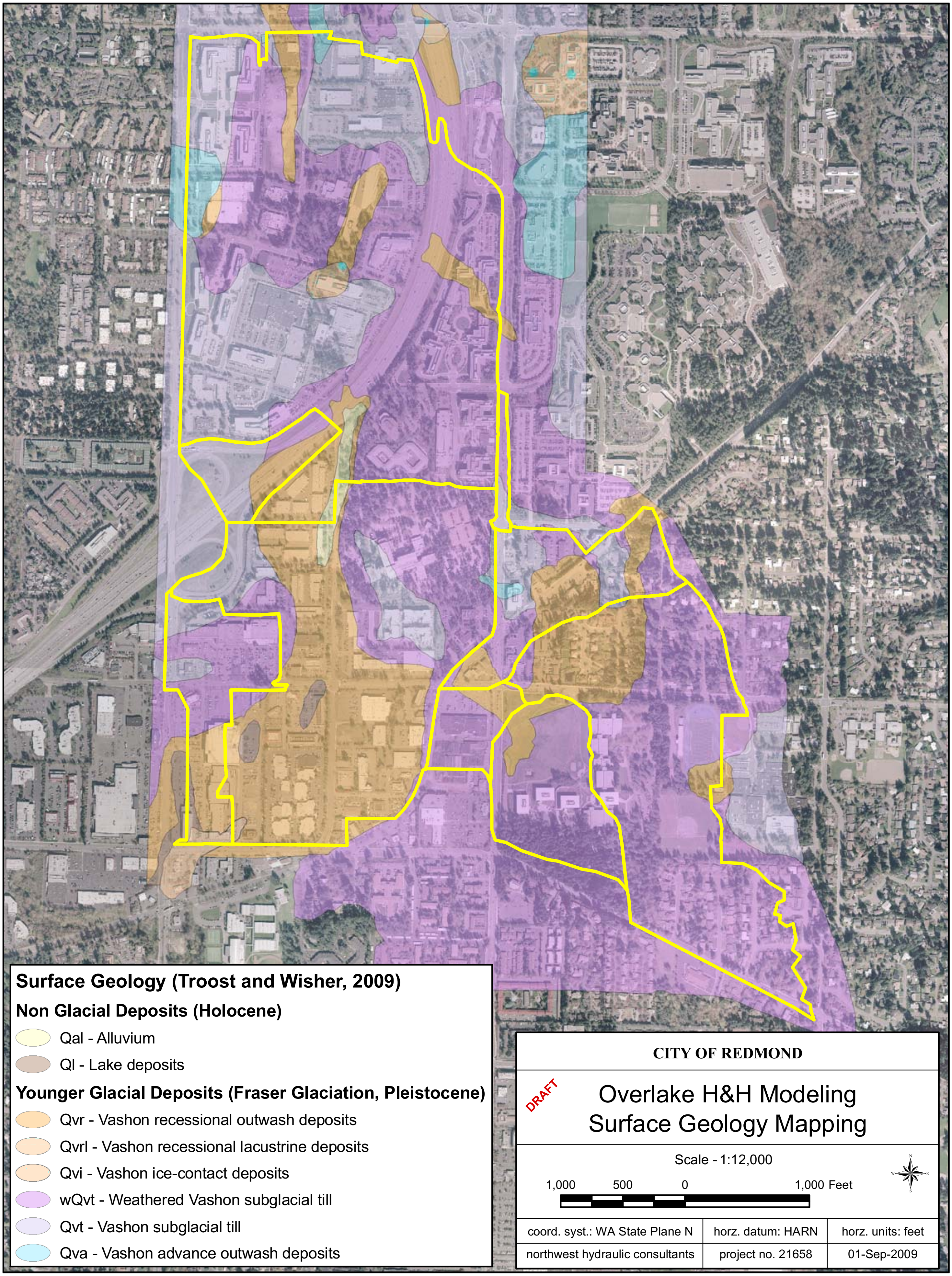
Surface Geology (Troost and Wisher, 2009)
Non Glacial Deposits (Holocene)
Qal - Alluvium
Ql - Lake deposits
Younger Glacial Deposits (Fraser Glaciation, Pleistocene)
Qvr - Vashon recessional outwash deposits
Qvrl - Vashon recessional lacustrine deposits
Qvi - Vashon ice-contact deposits
wQvt - Weathered Vashon subglacial till
Qvt - Vashon subglacial till
Qva - Vashon advance outwash deposits
CITY OF REDMOND
DRAFT
Overlake H&H Modeling
Surface Geology Mapping
Scale - 1:12,000
1,000
500
0
1,000 Feet
coord. syst.: WA State Plane N
horz. datum: HARN
horz. units: feet
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Figure 2

Basin Soils and Drainage

Previously published surface geology maps showed the entire Overlake drainage basin covered by glacial till from the Vashon glaciation. Using information from nearly 1,500 borings, probes, test pits, and wells in and around the basin, Troost and Wisher produced more detailed geology mapping of the Overlake basin in August 2009. The updated basin geology (Figure 2) shows the basin to be dominated by weathered till, which would be expected to have higher surface infiltration than standard till, as well as significant pockets of highly infiltrative outwash soils. A breakdown of the major soil categories by subbasin is shown in Table 2.

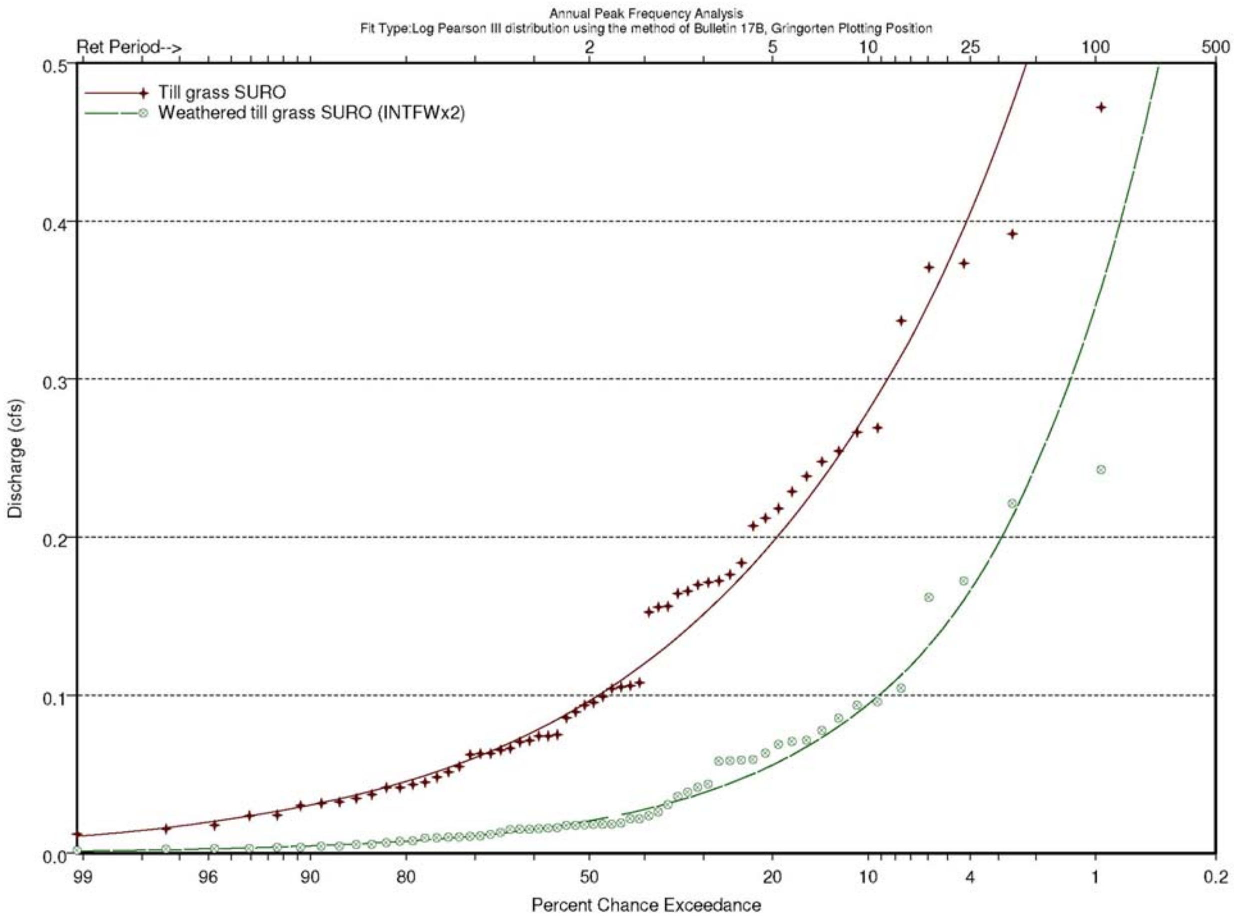
Table 2. Surface Geology Percentage by Subbasin

Subbasin	Till[1]	Weathered Till	Outwash[2]	Alluvial[3]
R-1a	12.5%	33.0%	51.5%	3.0%
R-1b[1]	53.9	15.1	31.0	0.0
R-1c	16.1	54.0	26.3	3.6
R-2a	34.0	52.7	12.2	1.1
R-2b[2]	38.5	61.5	0.0	0.0
B-1	26.7	32.2	41.1	0.0
B-2a	0.0	77.4	22.6	0.0
B-2b	0.2	80.9	18.9	0.0
B-2c	0.0	88.5	11.5	0.0
Total	20.0	53.3	25.4	1.3

[1]Includes 50% of area mapped as Qvi (ice contact).
[2] Includes advance (Qva) and recessional (Qvr, Qvrl) ourwash and 50% of area mapped as Qvi (ice contact).
[3] Includes alluvium (Qal) and lake deposits (Ql).

In previous modeling, regional parameters (after Dinicola, 1990) were used for till which was assumed to cover the entire basin. In the revised model, regional parameters were used for all units except weathered till. Weathered till was distinguished from standard till by doubling the value of the INTFW parameter The INTFW parameter controls the ratio of interflow (shallow subsurface runoff) to surface runoff. The result of this adjustment is higher surface infiltration (thus less surface runoff) and higher interflow. Infiltration to deep groundwater is not affected and would not be expected to be different from non-weathered till since the weathered till surface layer typically overlies solid till at depths of roughly three to ten feet. The effect of this modification on surface runoff frequency (on a per acre basis) is shown in Figure 3. Due to the highly impervious nature of the basin and limited calibration data, NHC did not feel that further calibration and deviation from regional HSPF parameters could be supported. For basin outflows as a whole, the effect of adjusting the INTFW parameter for weathered till is negligible for the small to moderate events that occurred during the calibration period. Annual peak flows for the basin are slightly reduced (on the order of zero to five percent) compared to previous modeling.

Figure 3. Till vs. Weathered Till Surface Runoff Comparison



Land Use and Cover

There were no changes to the land use data or approach in this update. Please refer to NHC's May 2009 report for full discussion of land use and land cover data and analysis.

Runoff and Flow Routing

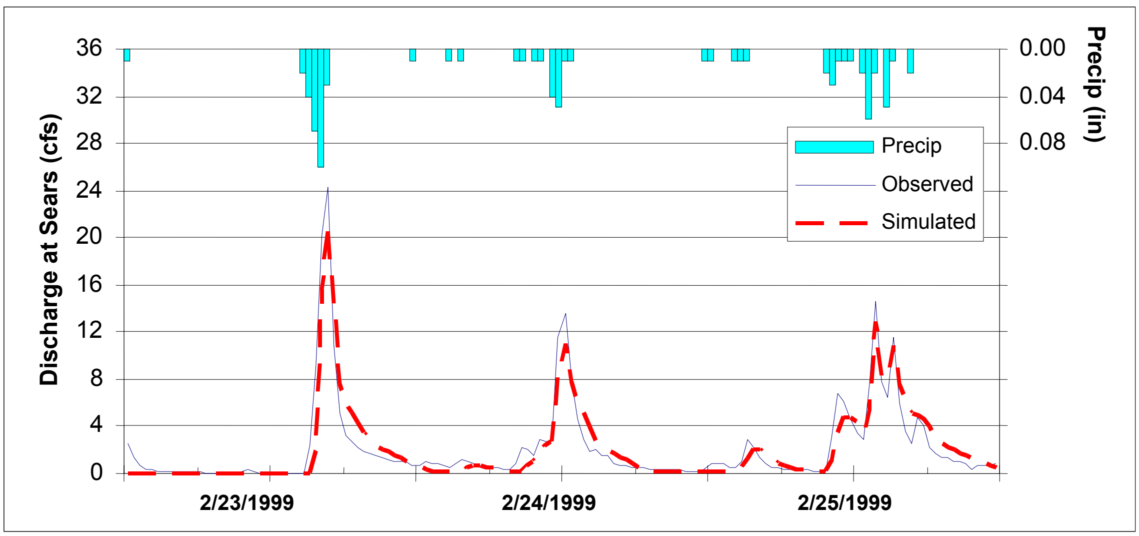
HSPF routing tables (FTABLEs) representing existing storage in the two large Redmond subbasins (R-1a and R-1b) were updated to include additional existing detention facilities (ponds and pipe vaults) identified in ongoing hydraulic modeling work. Single FTABLEs were developed to represent the combined detention in each subbasin. Storage volumes for these FTABLEs were determined from as-built information collected for the development of NHC's calibrated PC-SWMM hydraulic model of the basin.

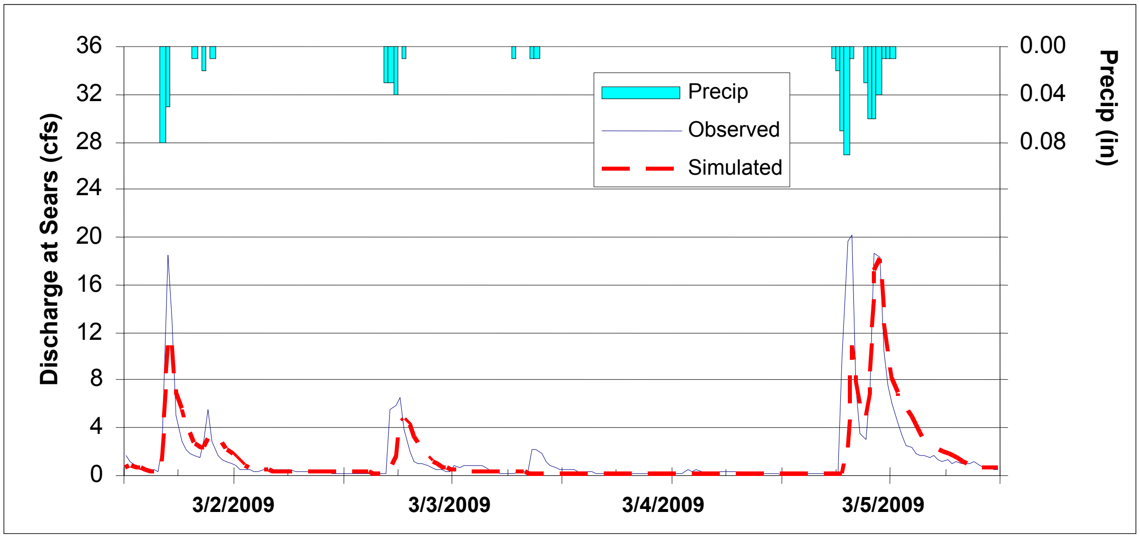
Model Verification

The updated existing conditions model was verified against observed flows at a gage in the Sears parking lot. This location receives stormwater from 95 percent of the study basin. Approximately three months of flow data were available for comparison, including two larger events that occurred after the initial modeling and calibration. Model verification results and hydrograph comparisons are shown below in Table 3 and Figure 4. Note that the scales for the larger May events in Figure 4 differ from those for the February and March events.

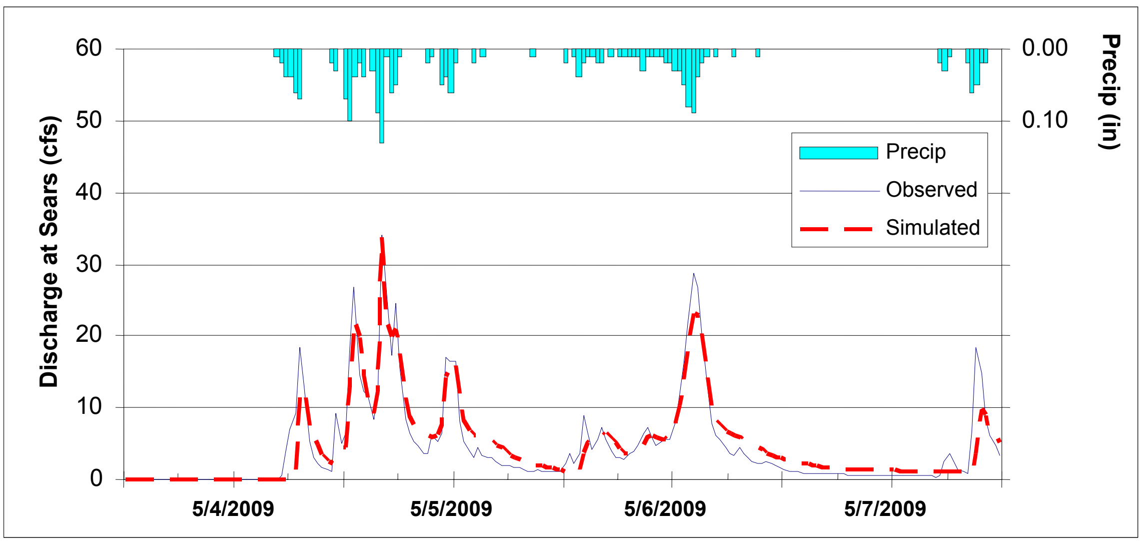
Table 3. Storm Peak and Volume Summary						
	Largest 30-min Peak Flow (cfs)			Event Volume (ac-ft)		
Period	Observed	Simulated	% Difference	Observed	Simulated	% Difference
Feb 23-25	24.2	21.2	-12.4	12.5	12.1	-3.3
Mar 2-5	20.2	18.2	-9.9	12.8	12.1	-5.9
Mar 25	17.6	17.4	-1.1	12.3	12.4	0.8
May 4-7	34.1	33.8	-0.9	36.7	37.7	2.8
May 13-14	19.3	17.6	-8.8	11.3	10.3	-8.5
May 18-20	44.6	46.5	4.3	15.5	16.5	6.6

Figure 4. Sample Model Verification Hydrographs

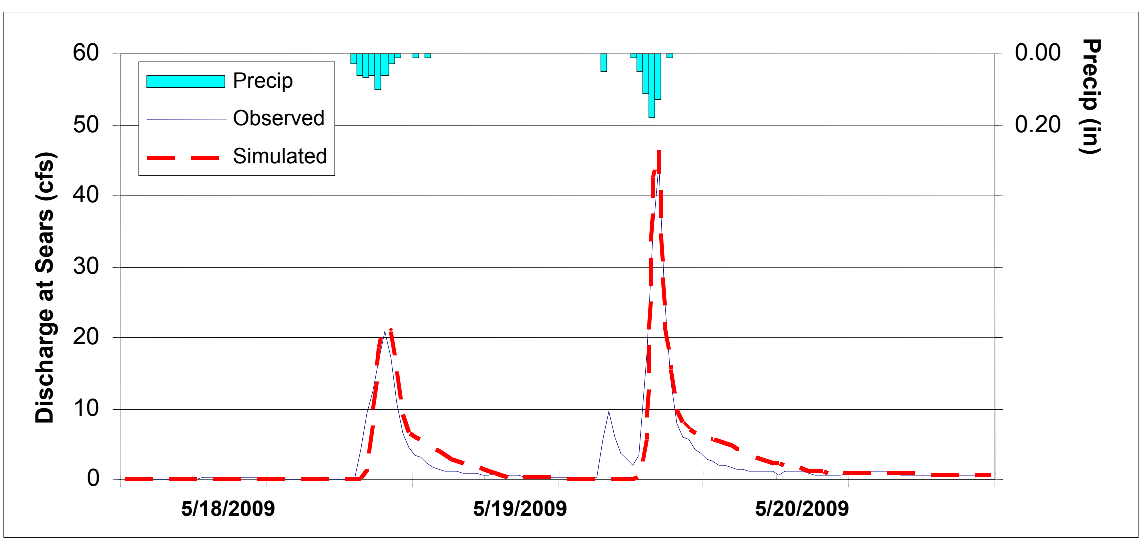




36
32
28
24
20
16
12
8
4
0
Discharge at Sears (cfs)
0.00
0.04
0.08
Precip (in)
Precip
Observed
Simulated
3/2/2009
3/3/2009
3/4/2009
3/5/2009



60
50
40
30
20
10
0
Discharge at Sears (cfs)
0.00
0.10
Precip (in)
Precip
Observed
Simulated
5/4/2009
5/5/2009
5/6/2009
5/7/2009



60
50
40
30
20
10
0
Discharge at Sears (cfs)
0.00
0.20
Precip (in)
Precip
Observed
Simulated
5/18/2009
5/19/2009
5/20/2009

As Table 3 and Figure 4 show, the model matches up well with event peaks and volumes for the small to moderate events that occurred during the calibration period. Peaks tend to be slightly low, though within 10 percent, for the smaller events but are very well simulated for the two larger events. Event volumes are well-simulated with no apparent systematic bias, though the simulated recessions are generally extended compared to the gage. This is likely due to the outlet control assumptions used for the hypothetical combined detention facilities and should not be significant for planned applications of the model. It is difficult to extrapolate how well the simulated flows would match up with actual basin response for much larger events, but given the highly impervious nature of the basin, which simplifies hydrologic response, it is reasonable to expect accuracy similar to the larger storms in Table 3.